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ECONOMICAL INSULATION TESTS

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Final Report

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Results of high voltage electrical discharge tests on various solid insulating material schemes for large gap insulation are reported along with test conduct. Six materials: plywood, polycarbonate, formica, styrofoam, polypropylene and mylar were tested singly, in multilayers, and in mixed multilayers. It was found that multilayer mylar gave the best improvement to gap holdoff while other materials actually degraded the holdoff.

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INTRODUCTION

This report presents the results of tests conducted with the Ferranti impulse generator (FIG) and the mobile upper electrode (MUE) to determine if there is a cost effective method to improve the electrical insulation of a given geometry. The materials tested (Table 1) were chosen based on their availability and cost.

BACKGROUND

In the past, the only way to reduce the physical size of any high voltage system was to immerse it in an insulating fluid. These fluids were either dielectric oil or an insulating gas, such as sulfur hexafluoride or freon. These fluids are very expensive and difficult to contain.

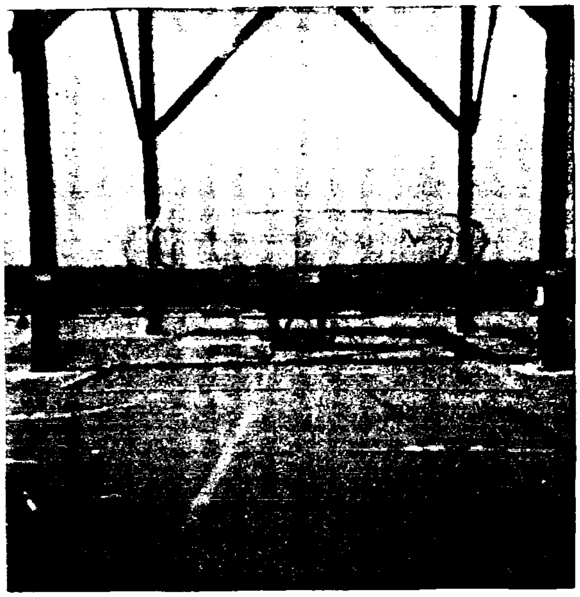
The volume and expense of fluids required to insulate most systems make it beneficial to find a lower cost insulating system. A scheme where a given gap in air would have a thin solid dielectric inserted into the geometry would be a highly cost-effective method to improve the insulating value.

TEST CONDUCT

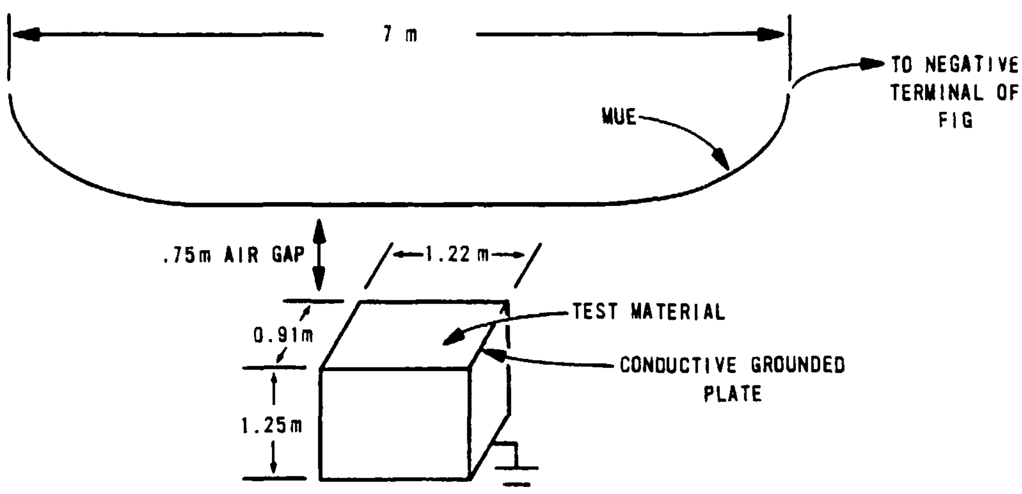
The 20-stage FIG was configured to produce a waveform with a 1.7 μs rise time and a 37 μs decaytime. The Mobile Upper Electrode (MUE) was raised to a height of 2 m above the ground plane (Fig. 1). This was done to establish a uniform field which could be enhanced.

The field was then enhanced by erecting a 1.22 x 0.91 m parallel plate test electrode 1.25 m above the ground plane and centered on the MUE (Fig. 2.). This was done so that when breakdown occurred, it would be between the test electrode and the MUE.

During the first test, the FIG voltage was increased gradually until a breakdown occurred across the 0.75 m air gap. The rest of the tests were made with the insulating materials placed on the test electrode. The insulating materials overhung the test electrode by at least 0.15 m on each side to preclude the arc going around the insulant. The FIG voltage was again gradually increased until breakdown occurred. This procedure was repeated at least three times for each material tested.



(a) Test set-up



(b) Test set-up schematic

Figure 1. Test set-up.

RESULTS

As can be observed from the data in Table 1, none of the materials tested provided an appreciable improvement in insulation above ambient air except for multiple layers of mylar which gave a 44 percent increase. Some materials such as styrofoam and polypropylene sheets are actually worse than ambient air. Except for multiple mylar layers, the above materials are not recommended for high voltage insulation.

TABLE 1. List of tested materials and results.

Insulation Material	Breakdown Voltage(kV)	Effectiveness Comparison	GAP Holdoff (MV/m)
Single sheets			
Air Gap, no insulation	333	1.00	0.444
Plywood, 3/4 in	423	1.27	0.564
Polycarbonate, 1/8 in	417	1.25	0.556
Formica, 1/16 in	417	1.25	0.556
Styrofoam, 1 in	320	0.96	0.427
Polypropylene, 10 mil	307	0.92	0.409
Mylar, 7 mil	372	1.12	0.496
Layered materials			
Polycarbonate, 1/8 in, 2 sheets	432	1.30	0.576
Formica, 1/16 in, 2 sheets	449	1.35	0.599
Polypropylene, 10 mil, 3 layers	378	1.14	0.504
Mylar, 7 mil, 2 layers	480	1.44	0.640
Layered dissimilar materials			
Polycarbonate - Formica	385	1.15	0.512
Polycarbonate	384	1.15	0.513
Formica - Plywood - Formica	362	1.09	0.483